

## TRAFFIC SIGNAL CONTROLLERS, CABINETS, AND STRUCTURES

The Standard Specifications are revised as follows:

SECTION 913, BEGIN LINE 2304, DELETE AND INSERT AS FOLLOWS:

**1. Model Approval.** Each model of ~~controller and its cabinet~~ *TS1 and TS2 controller assembly, CA, as defined in NEMA TS1-1.1.6 or TS2-1.1.7* will be tested, evaluated, and approved prior to use. *The CA includes electrical hardware mounted in a cabinet and all major units as defined by NEMA TS2-2.1.1 or TS1-2.1.1 and shall include controller unit, CU; master unit; malfunction management unit, MMU; conflict monitor; bus interface unit, BIU; cabinet power supply; detectors; load switches; and flasher relays.* ~~Testing, evaluation, and approval will require a minimum of 6 months to perform.~~ The period of evaluation will commence when the Department receives the preliminary product evaluation form accompanied by the product brochure, operational manual, maintenance manual, and documented theory of operation and parts listing. The ~~Procurement and Distribution Division~~ Department will advise the manufacturer or vendor, in writing, of the date to deliver the controller and cabinet, for which model approval is requested, to the Procurement and Distribution Division. Certification in accordance with ~~913.15(a)6f(2)~~ *913.15(a)5.1f(2) for TS1 and 913.15(a)6.1f(2) for TS2*, shall be received at the Procurement and Distribution Division a minimum of two weeks prior to the date of delivery of the ~~controller and cabinet~~ *CA or major unit*. Certifications in accordance with ~~913.15(a)6f(1)~~ *913.15(a)5.1f(1) or 913.15(a)6.1f(1)*, schematics for the ~~controller and cabinet~~ *CA or major unit*, operational manuals, theory of operation and parts lists shall be furnished with the ~~controller~~ product when it is submitted to the Procurement and Distribution Division for evaluation and testing. The ~~controller and cabinet~~ *CA or major unit* will undergo the bench test in accordance with ~~913.15(a)4. A controller~~ *The CA or control major unit* that fails the bench test procedure three times will be rejected and will not be placed upon the approved products list, nor will it be considered for future evaluation without documented changes to design. A list of approved models will be maintained by the Department. Only models from the approved list of control equipment in effect as of the date of letting, or as otherwise specified, shall be used in the contract. Continued failure and repeated malfunctions of an approved controller or control equipment shall be cause to remove that model from the Department's list of approved products.

A design change to an approved model of ~~controller~~ *CU*, will require a resubmittal of

the model for testing, evaluation, and approval. Permanent addition or removal of component parts or wires *and software changes to a CU* will be considered to be a design change. *Notification of a software change in a CU shall be given to the Operations Support Division's Evaluation Section and shall include documentation that reveals all programming changes, additional parameters, or non-proprietary modifications to the CU. Changes in software may not require a full evaluation.*

## **2. ~~Controllers or Control Units~~ Controller Assembly Furnished and Installed by the Contractor.**

A controller with all components of equipment, necessary for an operating signal, wired into a cabinet will be a ~~control unit~~ CA. The Contractor shall prepare three packets for each

~~control unit and provide these packets to the Engineer~~ CA. Packet 1 shall consist of one complete set of wiring and schematic diagrams for the ~~control unit and its appurtenances~~ CA, and a listing of *each* model name/number and serial number of the removable equipment that

can be readily exchanged or replaced, such as controller enclosure, controller modules, ~~load switches, conflict monitor, detectors, and flashers~~ and major units described in NEMA TS2-2.1.1, and an intersection design drawing. Packets 2 and 3 shall be provided to the Engineer and each packet shall consist

of the same items as in Packet 1 plus ~~a descriptive parts list and instruction and maintenance manuals that include the manufacturer's data sheets on each different type of I. C. chip being used, connection diagrams, voltage checks and the theory of operation.~~ an operational manual for major units. Packets 2 and 3 shall identify the date of installation. Each packet shall be labeled with the name of the intersection, the Contract Number, or agreement and the

Commission Number ~~and the date of installation~~. Packet 1 ~~will~~ shall be forwarded to the Procurement and Distribution Division, *Electronic Technician Supervisor, prior to installation.* ~~packet~~ Packet number 2 will be retained in the controller cabinet, and ~~Packet~~ packet 3 will be retained by the District Traffic Office.

The Contractor shall be responsible for all costs associated with vendor or manufacturer warranty service until acceptance of the contract, or acceptance of that portion of the contract where the traffic control equipment is installed.

## **3. Blank.**

## **4. Bench Testing.**

~~The Department's Traffic Signal Control Bench Test Procedures, which are used for bench testing of traffic signal controllers, cabinets, and related equipment are on file and available upon request.~~

During bench testing a ~~control unit~~ CA will be considered as failed if one of the

following conditions are encountered during the physical or operational test procedure:

- a. ~~The controller unit CU skips intervals, or phases, places false calls, presents false indicator lights, does not follow the prescribed sequence or exhibits changes in timing beyond the, phase, ring, unit functions; coordination; preemption; time base coordination; telemetry; and functions noted in manufacturer manual do not operate within designated tolerances of the NEMA TS1/TS2 specifications.~~
- b. The load switches produce incorrect signal indications.
- c. The conflict monitor *or* MMU fails to perform in accordance with the specifications ~~of the requisition or contract.~~
- d. ~~Major units of the CA or Auxiliary auxiliary equipment such as pre-emptors, coordinators, or detectors~~ do not operate in accordance with the specifications.
- e. The wiring for the interface of ~~any items set out above the CA~~ is defective or incorrect.

If the ~~control unit~~ CA fails the bench test procedure, the ~~control unit~~ CA shall be removed from the Procurement and Distribution Division for repairs and returned to the Traffic Support Center for retesting. The cover letter for the resubmittal of the ~~control unit~~ CA for retesting shall include an explanation of why the unit failed and what specific repairs were made.

A written test report will be provided for each ~~control unit~~ CA tested. A representative of the manufacturer or vendor may be present during the bench testing procedure.

SECTION 913, BEGIN LINE 2398, DELETE AND INSERT AS FOLLOWS:

**(a) General.** The controller shall have a keyboard entry or keyboard entry backlit liquid crystal display menu-driven type with internal pre-emption, time base coordination, telemetry, printer, and interconnect modules. The ~~controller unit~~ CU shall contain a printer interface module, which permits a hard copy printout of all keyboard settings. The unit shall employ circuit designs, consistent with the latest techniques, using

SECTION 913, BEGIN LINE 2440, DELETE AND INSERT AS FOLLOWS:

Any external battery within the ~~controller unit~~ CU shall be turned off or

disconnected  
during shipment and storage.

SECTION 913, BEGIN LINE 2459, DELETE AND INSERT AS FOLLOWS:

The ~~controller-unit~~ *CU* shall be able to operate as a master controller or a secondary controller without requiring any changes in the unit itself. When used as a master controller, it shall not be required to program the units offsets to zero. The ~~controller-unit~~ *CU* shall be capable of operating in an existing pretimed interconnected systems, which may have an electromechanical interrupter utilizing 115 volts, 60 hertz, AC. Cycle, offset, and split selectability shall be either by application of 115 volts, 60 hertz AC to the fuse panel or manually from the keyboard. Use of 115 volts AC Interconnect to a 24 volts DC logic interface is acceptable. As a minimum, the controller shall be capable of accepting nine conductors for interconnect, two conductors for cycle 1-4 selection, three conductors for reset 1-3 selection, two conductors for split 1-4 selection, and one conductor each for flash and common.

With each ~~controller-unit~~ *CU* and cabinet there shall be furnished three complete sets of wiring and schematic-diagrams, two descriptive parts lists, two instruction and maintenance manuals that include the manufacturer's data sheets on each different type of integrated circuit chip being used that has not been previously submitted to and on file at the Procurement and Distribution Division, connection diagrams, voltage checks and the

SECTION 913, DELETE LINES 2499 THROUGH 2501.

SECTION 913, BEGIN LINE 2623, DELETE AND INSERT AS FOLLOWS:

**f. Certification of Traffic ~~Control Units~~ Controller Assemblies.**  
Certification of traffic ~~control~~  
~~units~~ *CA* shall be in accordance with 913.15(a)6f.

**g. Warranty.** The warranty for traffic ~~control-units~~ *CUs* shall be in accordance with 913.15(a)6g.

SECTION 913, AFTER LINE 2628, INSERT AS FOLLOWS:

**5.1 NEMA TS2 Pretimed Controller Unit and Controller Assembly.** *The following are the minimum requirements for the design and operation of a pretimed digital, solid-state CU, configuration type P1 and P2. The CU shall be a digital, menu driven unit with a backlit liquid crystal display. The CU shall meet specifications of NEMA TS2-3.4. The CA shall meet all applicable specifications of NEMA TS2, all provisions contained within this document, and the Departmental traffic signal bench test procedure. The requirements contained herein and the bench test procedures shall govern over NEMA standards.*

*All CU type P1 and type P2 shall be fully functional, with TBC, coordination, preemption, telemetry and printer modules installed.*

*All indicators shall be of the liquid crystal design. All programming keyboard and indicators pertinent to the operation of the unit shall be on the front of the CU. The unit shall have programmable phase omitting and phase skipping capabilities.*

*The backlit liquid crystal display shall have a minimum four lines with 40 characters each. The display shall be a high resolution type display such that the display shall be readable on a plane of 0.60 m (2 ft) in front of, and parallel to the display window. As a minimum the display shall be readable throughout a vertical 60 degree angle that contains a minus 15 degree angle to a plus 30 degree angle measured from the horizontal plane that is perpendicular to the center of the display. Also the display shall be readable throughout a horizontal 60 degree angle that contains a 30 degree angle on either side of a vertical plane that is perpendicular to the center of the display window. The backlit liquid crystal display shall have a diffusion type lens or membrane to reduce surface glare.*

**a. Spare Modules.** *All spare modules shall be in accordance with 913.15(a)6.1b and with the applicable requirements of the NEMA TS2 standards.*

**b. Controller Enclosure.** *The enclosure shall be of adequate physical strength to protect the components during normal physical handling. Fusing, keypad, liquid crystal display, and input-output connectors required for the operation and standard field adjustments shall be mounted on the front panels.*

*The main frame shall be completely equipped and wired as a complete pretimed controller so that no additional hardware or wiring is required. The front panel of the controller shall be positively fastened to the frame. Special tools shall not be required to remove or replace modules or plug connected printed circuit boards.*

**c. Power Requirements.** *The controller shall operate in accordance with NEMA TS2-2 standard.*

**d. Certification of Traffic Controller Assemblies.** *Certification of traffic CA shall be in accordance with 913.15(a)6.1f.*

**e. Warranty.** *The warranty for traffic CA shall be in accordance with 913.15(a)6.1g.*

SECTION 913, BEGIN LINE 2684, DELETE AND INSERT AS FOLLOWS:

Controllers shall be capable of servicing eight phases. The ~~control unit~~, CU when delivered, shall be programmed to initialize in phase 2 and phase 6 green. The controller

SECTION 913, BEGIN LINE 2734, DELETE AND INSERT AS FOLLOWS:

**f. Certification of ~~TS1 Traffic Control Units~~ *Controller Assemblies*.**

The following certifications  
shall be furnished in accordance with the applicable provisions of 916.

**(1) Certification of a Production Run Model.** A Certification for a model of ~~control-unit~~ *CA* shall be on file with the Department. A production run model

SECTION 913, BEGIN LINE 2743, DELETE AND INSERT AS FOLLOWS:

certification shall be submitted. A significant change shall be the addition or deletion of any function or feature in the ~~control-unit~~ *CU*, or any major change to the circuitry in the ~~control-unit~~ *CU*.

**(2) Certification of Environmental Testing.** A certification shall be furnished with each ~~control-unit~~ *CA* approval indicating it has been tested and is in accordance with the following tests from NEMA Standards TS1-2.

SECTION 913, BEGIN LINE 2773, DELETE AND INSERT AS FOLLOWS:

**g. Warranty.** A standard manufacturer's warranty shall be furnished for each traffic signal ~~control-unit~~ *CA* which is furnished and installed. The effective date for the beginning of the warranty shall be the turn-on date shown on Form I.C. 636A. The warranty shall be provided prior to final acceptance.

Each traffic signal ~~control-unit~~ *CA* purchased by the Department shall have a minimum ~~2~~ two year operational warranty or the manufacturer's standard warranty, whichever is longer. The ~~2~~ two year warranty shall begin on the date the ~~control-unit~~ *CA* is received at the Procurement and Distribution Division. *The warranty shall service all defects in material or workmanship of equipment. The manufacturer shall not be responsible for damage caused by negligence, severe weather acts such as lightning, flood, etc., or use of equipment in a manner not originally intended.* The vendor or manufacturer shall

SECTION 913, BEGIN LINE 2789, DELETE AND INSERT AS FOLLOWS:

Continued failure and repeated malfunctions of an approved model of ~~controller~~ *CU or major unit* shall be cause to remove that model from the Department list of approved models.

*These standards define the minimum requirements for NEMA TS2, Type A1 and Type A2 traffic control system devices.*

SECTION 913, AFTER LINE 2791, INSERT AS FOLLOWS:

**6.1 NEMA TS2 Fully-Actuated Traffic Controller.** *The following are the minimum requirements for the design and operation of a 8 phase fully-actuated digital,*

*solid-state CU. The CU shall be a digital, menu driven unit with a backlit liquid crystal display. The CU shall be in accordance with NEMA TS2-3 and the Department's traffic signal bench test procedure. The requirements contained herein and the bench test procedures shall govern over NEMA standards.*

**a. General.** *The NEMA TS2 fully-actuated Traffic CU will consist of two types of controller units, type A1 and type A2, as defined in NEMA TS2-3.2. Both versions shall contain a three port configuration and shall operate in the NEMA TS2 type A1 environment. Communication between the BIU, MMU, and the CU shall be accomplished through a high speed communications system within the controller assembly utilizing SDLC Protocol as defined in NEMA TS2-3.3.1 and be in accordance with all applicable requirements in NEMA TS2.*

*Where zero powered RAM is utilized, the battery shelf life, with load, shall be a minimum of five years. The time base coordination system time-of-day clock shall be maintained during power outage. A switch or other means shall be provided to turn off or disconnect external battery power during storage. This shall be accomplished without physical removal of the battery.*

*Each CU purchased by the Department as a spare or replacement unit shall include a complete set of CU operational and maintenance manuals. The manuals shall include complete CU schematic diagrams, operational and programming procedures, theory of operation, and descriptive parts lists. The operational manual shall include explicit programming instructions for all NEMA features and all additional features incorporated into the unit by a manufacturer. All schematic diagrams shall include numbered test points with voltage reading or waveforms at these test points.*

*Serial numbers shall be applied to all internal modules of the CU. The model number and serial number of the CU main frame shall be permanently applied externally on or near the front panel.*

**b. Controller Requirements.** *The requirements set forth here refer to a type A1 and type A2. Where differences occur between type A1 and A2 it will be designated.*

*If the CU timing parameters are greater than defined by NEMA TS2, the greater time setting shall be functional in the CU.*

*If the CU has additional functions not required by NEMA TS2, these additional functions shall be active and shall operate in accordance with the manufacturer's specification, operational and programming manuals. An additional function or device shall not cause the CU to be exclusively proprietary to a controller assembly or vice versa.*

*All controller units type A1 and type A2 shall be fully functional, with TBC, coordination, pre-emption, telemetry, and printer modules installed.*

*All indicators shall be of the liquid crystal design. All programming keyboards and indicators pertinent to the operation of the unit shall be on the front of the CU. The unit shall have programmable phase omitting and phase skipping capabilities.*

*The backlit liquid crystal display shall have a minimum 4 lines with 40 characters each. The display shall be a high resolution type display such that the display shall be readable on a plane of 0.60 m (2 ft.) in front of, and parallel to the display window. As a minimum, the display shall be readable throughout a vertical 60 degree angle that contains a -15 degree angle to a +30 degree angle measured from the horizontal plane that is perpendicular to the center of the display. Also, the display shall be readable throughout a horizontal 60 degree angle that contains a 30 degree angle on either side of a vertical plane that is perpendicular to the center of the display window. The backlit liquid crystal display shall have a diffusion type lens or membrane to reduce surface glare.*

*The CU shall be capable of servicing all inputs and outputs listed by controller type in NEMA TS2-3. When delivered, the CU shall be programmed to initialize in phases 2 and 6 green. The CU shall be keyboard programmable to allow initialization in each phase and color after a recognized power interruption or upon MMU reset, or upon return from manual or time-of-day flash.*

*Overlaps shall be keyboard programmable and shall have the capability of independent timing in accordance to TS2-3.5.8.*

*The time-of-day programming shall be capable of a minimum of 50 programmed events. The non-interconnected coordination shall be capable of a minimum of 100 program steps. The time base shall be in accordance with TS2-3.8.*

*The CU shall be capable of coordination in accordance with NEMA TS2-3.6.*

*Priority of input functions shall be in accordance with TS2-3.4.6. When a non-interconnected program, plan, or cycle-split-offset are manually programmed to On through the keyboard, that program will take priority over the telemetry or hardwire program in operation at that time. A minimum of ten non-interconnected coordination line functions may be enabled at a given turn-on time.*

*The CU shall be programmable from a closed loop computer system, a laptop computer using the RS232 port, front panel programming, and by downloading from another like controller unit through the RS232 port.*

*The CU shall have internal diagnostics as specified in TS2-3.9.3.*



*The NEMA TS2 type A2 version, in addition to operating in the NEMA TS2 type A1 environment, shall operate in the NEMA TS1 environment. The type A2 CU shall contain the required NEMA TS2 ports 1, 2, and 3; the NEMA TS1 military style connectors A, B, C; and an auxiliary I O (D) connector. The type A2 CU shall have type A1 and type A2 I/O interface modules and have full functionality in that manufacturer's TS1 CA. The CU shall be in accordance with all applicable requirements for a type A2 CU in NEMA TS2-3.*

*As a minimum, all internal module plugs and edge card plugs shall be labeled with the first and last number, or first and last letters corresponding to the pin connector position. All required CU fusing shall be on the front panel and shall protect the unit from internal overloads.*

***c. Spare modules.** All spare modules shall be in accordance with 913.15(a)6.1b and with the applicable requirements of the NEMA TS2 standards.*

***d. Controller Unit Enclosure.** The enclosure shall be in accordance with the NEMA TS2 standard and shall be of adequate physical strength to protect the internal modules and components during normal transporting and handling. All fusing, programming keypads, liquid crystal displays, and required connectors shall be on the controller unit front panels.*

*The main frame shall be equipped and wired as a complete eight phase NEMA TS 2 CU so that no additional hardwire is required. The front panel of the CU shall be positively fastened to the main frame such that no special tools shall be required to open the front panel. No special tools shall be required to remove or install internal modules.*

***e. Power requirements.** The CU shall operate in accordance with in the NEMA TS2-2 standard.*

***f. Certification of NEMA TS2 Controller Assembly.** The following certifications shall be furnished in accordance with the applicable provisions of 916.*

***(1) Certification of a Production Run Model.** A Certification for a model of CA or major unit shall be on file with the Department. A production run model shall be tested in accordance with, and comply with, all requirements of NEMA TS2-2 including shock and vibration. A certification of a production run model will be valid for a maximum period of four years from the date of testing or unless a significant change is made in the CU. If a significant change is made a new certification shall be submitted. A significant change shall be the addition or deletion of a function or feature in the CA, or a major change to the circuitry in the controller assembly.*

***(2) Certification of Environmental Testing.** A certification shall*

be furnished with each CA approval indicating that it is in accordance with all environmental requirements of NEMA TS2-2 and has been tested and is in accordance with the following tests from NEMA TS2:

- TS2-3.13-10 Power interruption test.
- TS2-3.13.1 Timing accuracy tests.
- TS2-3.13.7 Test Procedure - Transients, Temperature, Voltage, and Humidity.
- TS2-3.13.8 Vibration and shock tests.
- TS2-4.6.1 Malfunction Management Unit Test.
- TS2-7.9 Cabinet ventilation requirements.

The cabinet requirements shown in 913.15(a)7.1 shall be applicable during the appropriate tests.

The certification shall specify the model and serial number of the following components: cabinet, CU enclosure, CU modules, MMU, BIU, terminal and facilities (TF) power supply, detectors, load switches, flasher, and all specified auxiliary control equipment.

A complete log of each test for every CU shall be maintained. The log shall show which, if any, CU component failed during the test, when it failed, and what steps were taken to repair the CU unit. The log shall include the date of testing, name and title of person conducting the tests, a record of conditions throughout the tests, and a temperature and humidity vs. time chart. The maximum revolution of each chart shall be 24 hours. The chart shall be developed from a recording machine used to monitor the status of the environmental chamber during testing.

**g. Warranty.** A written five year manufacturer's warranty shall be furnished for each traffic signal CA which is furnished and installed. The effective date for the beginning of the warranty shall be the turn-on date shown on Form I.C. 636A. The warranty shall be provided prior to final acceptance.

Each traffic signal CA purchased by the Department shall have a minimum five year manufacturer's warranty or the manufacturer's standard warranty, whichever is longer. The five year warranty shall begin on the date the CA is received at the Procurement and Distribution Division.

The warranty shall service all defects in material or workmanship. The manufacturer shall not be responsible for damage caused by negligence, severe weather acts such as lightning, floods, etc., or use of equipment in a manner not originally intended. The vendor or manufacturer shall be responsible, during the warranty period, for transportation costs to and from the Procurement and Distribution Division for items requiring warranty service.

*Continued failure and repeated malfunctions of an approved model of controller shall be cause to remove that model from the Department list of approved models.*

SECTION 913, BEGIN LINE 2925, DELETE AND INSERT AS FOLLOWS:

**(1) Cast Aluminum Pedestal Base.** ~~All pedestals mounted G~~  
~~cabinet shall~~  
 have a cast aluminum pedestal base. The ~~cabinet and~~ pedestal base shall be ground mounted on a concrete type A foundation at locations and dimensions as shown on the plans.

The cast aluminum base shall be made of aluminum in accordance with ASTM B 179, alloy ANSI 319.1 or 319.2, or in accordance with ASTM B 26M (ASTM B 26), alloy ANSI 356.0-T6. The square base shall include an access door and anchor bolts with nuts and washers. The base shall be ~~8630~~ 340 mm (13 3/8 in.) square and 380 mm (15 in.) in height ~~32 ± 5 mm~~ (4 ± 1/4 in.). The weight shall be 10.0 kg ± 2.2 kg (22 lbs ± 5%).

SECTION 913, BEGIN LINE 2947, DELETE AND INSERT AS FOLLOWS:

The base shall be attached to a foundation by four anchor bolts, ~~with an anchor bolt circle of 324 mm (12 3/4 in.) in accordance with 913.15(a)7e.~~ Slotted lugs shall be integrally cast into the four corners of the base for attachment of the anchor bolts. ~~The anchor bolts shall be steel in~~

SECTION 913, DELETE LINES 2950 THROUGH 2960.

SECTION 913, LINE 2972, DELETE AS FOLLOWS:

**(2) Pedestal Pole.** ~~The top of the base shall accommodate a pole~~

SECTION 913, DELETE LINES 2973 THROUGH 2983.

SECTION 913, BEGIN LINE 2985, DELETE AND INSERT AS FOLLOWS:

~~An aluminum~~ All pedestal poles shall be *aluminum* in accordance with ASTM B 241M (ASTM B 241) for seamless aluminum alloy, schedule 40, 6061-T6. ~~The outside diameter of the pole shall be 114 mm (4 1/2 in.).~~ The length of the pole shall be as shown in the plans.

SECTION 913, BEGIN LINE 2997, DELETE AS FOLLOWS:

A cast pole cap shall be made of aluminum, in accordance with ASTM B 179, alloy ANSI 319.1 or 319.2. The cap shall fit freely on the ~~114 mm (4 1/2 in.) outside diameter~~ pole. A set screw using a 19 mm 3/4 in.) No. 12 hex head machine screw shall be supplied to hold the cap on the pole. A standard foundry draft will be allowed on the casting.

A pole cap made from spun aluminum shall be in accordance with ASTM B 209M (ASTM B 209), alloy 1100-0. The cap shall ~~to~~ fit tightly when placed on the end of

the pole.

SECTION 913, BEGIN LINE 3007, INSERT AS FOLLOWS:

**c. M Cabinet.** The M cabinet shall be ground-mounted on a concrete foundation at locations and dimensions as shown on the plans *with anchor bolts in accordance with 913.15(a)7e.*

SECTION 913, DELETE LINES 3013 THROUGH 3021.

SECTION 913, BEGIN LINE 3091, DELETE AND INSERT AS FOLLOWS:

**d. P-1 Cabinet.** The P-1 cabinet shall be ground mounted on a concrete foundation at locations and dimensions as shown on the plans with anchor bolts in accordance with 913.15(a)7e *e.* The P-1 cabinet shall house an 8 phase traffic actuated solid

state digital controller and shall have two adjustable shelves with the first shelf located 508 mm (20 in.) below the top of the cabinet and the second shelf 178 mm (7 in.) below the first shelf. The cabinet shall be 1118 mm(44 in.) wide, 1321 mm (52 in.) high, and 610 mm (24 in.) deep with a tolerance of  $\pm 75$  mm (3 in.) inches in all dimensions. Maximum exterior dimensions shall be 864 mm (34 in.) deep, 1194 mm (47

SECTION 913, AFTER LINE 3114, INSERT AS FOLLOWS:

*e. **Anchor Bolts.** The anchor bolts shall be steel in accordance with ASTM A 36M (ASTM A 36). The top 100 mm (4 in.) of the bolt shall be threaded with 10 NC threads. The threads plus 75 mm (3 in.) shall be coated after fabrication in accordance with ASTM A 153 or be mechanically galvanized and in accordance with the coating thickness, adherence, and quality requirements of ASTM A 153, class C.*

*Each anchor bolt for pedestal foundations shall be provided with two hex head nuts in accordance with ASTM A 325M (ASTM A 325) and three washers. Two of the washers shall be in accordance with ANSI B 27, Type B regular series, and one shall be a series W washer in accordance with ASTM F 436M (ASTM F 436).*

*Each anchor bolt for controller foundation shall be provided with one hex head nut and one flat washer. The hex head nut and flat washer shall be galvanized in accordance with ASTM A 153 or be mechanically galvanized and in accordance with the coating thickness, adherence, and quality requirements of ASTM A 153, class C.*

**7.1 NEMA TS2 Cabinet, and Terminal and Facilities (TF).** *These standards define the minimum requirements for size 5 and size 6 TS2 Type A1 and A2 cabinet and the TF within the cabinet.*

*The performance and construction of the cabinet and TF shall be in accordance with the applicable requirements of NEMA TS2 sections 4, 5, 6 and 7. The NEMA TS2 Type A1 or Type A2 control cabinets shall be in accordance with the following requirements.*

**a. General.** *The cabinet and the shelf, if needed, shall be fabricated of aluminum. The cabinet shall be 3 mm (0.125 in.) minimum thickness sheet aluminum or 6 mm (0.25 in.) minimum thickness die-cast aluminum. The cabinet exterior and interior including shelves, shall have a sandblasted, roughened, or chemically etched finish that reduces gloss, reflection, and glare.*

*The main cabinet door shall use a Corbin Lock No. 2. The lock shall be furnished with two keys. The door shall be capable of being opened and stopped in at least the following two ranges of degree opening as measured from the face of the cabinet door on the hinged side: 80° to 100°, and 150° to 180°. The door shall be hinged on the right side of the cabinet.*

*The cabinet shall have a police door and a police control panel, within the main door. The police panel shall contain two separate switches, one switch for the master power cut off and one switch to change automatic signal control to flashing operation and vice versa. The switches shall be protected from water when the cabinet door is opened. The police door shall be weather tight and shall use a standard Corbin Police panellock. Two keys shall be furnished for the police door.*

*The size 6 cabinet shall have two adjustable shelves with first shelf 510 mm (20 in.) from top of the cabinet and the second one located 180 mm (7 in.) below the first shelf. The cabinet shall be 1120 mm (44 in.) wide, 1320 mm (52 in.) high, 610 mm (24 in.) deep with a tolerance of  $\pm 75$  mm (3 in.) in all dimensions. Maximum exterior dimensions shall be 860 mm (34 in.) deep, 1190 mm (47 in.) wide, and 1600 mm (63 in.) high.*

*The size 5 cabinet shall have two adjustable shelves with the first shelf located a minimum of 305 mm (12 in.) from the top of the cabinet, with adequate room to install controller, power supply and MMU. The cabinet shall have dimensions of 760 mm (30 in.) wide, 1220 mm (48 in.) high, and 410 mm (16 in.) deep with a tolerance of  $\pm 50$  mm (2 in.) in any or all dimensions.*

*The cabinet ventilation shall be in accordance with NEMA TS2-7.9. The size 5 and size 6 cabinets shall have inlet air ventilation openings in the cabinet door of adequate size to provide sufficient air circulation within the cabinet. The cabinet shall have a disposable air filter.*

*The cabinet shall contain a thermostatically controlled ventilating fan. The thermostat shall be manually adjustable from 21 °C to 38 °C (70 ° to 100 °F). The fan shall be mounted internally at the top and toward the front of the cabinet to exhaust out the front top lip of the controller cabinet. The thermostat shall be located within 150 mm (6 in.) of the fan.*

*The CU and MMU cables shall be of sufficient length to allow the units to be placed on either shelf or the outside top of the cabinet in the operating mode. All connecting cables/wire harnesses to the CU, MMU, TF power supply and detector rack and all wire size 10 AWG and smaller routed to the police panel shall be sleeved in a braided nylon mesh or PVC jacket. No wires within these cables with the exception of chassis ground wire termination points, not to exceed 75 mm (3 in.) in length, shall be exposed. Polyethylene spiral wrap tubing will not be accepted.*

*The cabinet shall have enough RS-485 Port 1 communication cables to allow full capabilities of cabinet. The cable shall be shielded cable suitable for RS-485 communication.*

*The cabinet shall contain one duplex convenience outlet and a switch controlled lamp receptacle. The convenience outlet shall be duplex, three-prong, NEMA Type 5-15R grounding outlet in accordance with NEMA WD-6, with ground-fault circuit interruption as defined by the National Electric Code. These units shall be protected with a 15 A cartridge fuse wired ahead of the multi breakers.*

*The cabinet shall have a main TF backpanel as described in NEMA TS2-5. The model/part number of the TF shall be permanently applied to the front of the panel, where it is easily readable without removing or disconnecting the panel.*

*The TF of four, eight, and twelve/expandable to sixteen position backpanel shall be hinged or capable of swinging down, making the TF readily accessible and allowing access to all wiring on the rear of the panel. If a hinge is utilized, the hinge shall traverse the entire width of the main panel. It shall not be necessary to completely remove TF panels to access the back side.*

*The TF shall have all logic level, CU, and MMU input and output terminations permanently labeled. The field terminal strips and auxiliary field termination points shall be consecutively numbered in accordance with the prints and schematics. All designations shall be silk screened as for function and terminal number corresponding to the cabinet print designations. Terminal numbers on the backside of the TF panel shall also be permanently numbered with silk screening.*

*All load switch and flash transfer relay socket reference designators shall be silkscreen labeled on the front and rear of the TF panel to match the drawing designations.*

*The CA power panel shall contain a multi-breaker with one 10 A circuit breaker to provide overload protection to the CU, MMU, detectors, and 12/24 volts, DC power supply; and one 35 A circuit breaker to provide overload protection to the signal and flash buss load. With the 10 A and 35 A circuit breaker in the off or tripped position, the signal output, CU, MMU and the 12/24 volts, DC power supply shall be turned off. The*

*signal shall operate in the flash mode with the 10 A circuit breaker off and the 35 A circuit breaker on. The controller, MMU, TF power supply, detectors, and BIUs shall operate with the 10 A circuit breaker on and the 35 A circuit breaker off.*

*The CA shall include a filtering surge protector (surrestor). The filtering surge protector (surrestor) shall be wired behind the multi-breaker, in parallel with the signal buss 35 amp circuit breaker and in series with the 10 amp circuit breaker for the solid state electronic equipment such as CU, MMU or conflict monitor, 12/24 volts, DC power supply, detectors, etc. The surrestor shall have a maximum clamp voltage of 250 V at a peak current of 20,000 A for a minimum of 25 occurrences.*

*The surrestor shall have not more than 30 V variation above and below the sine wave at all phase angles. The surrestor shall operate between -40 °C to 85 °C (-40 °F to 185 °F). The dimensions of the unit shall not exceed 90 mm (3.5 in.) wide by 180 mm (7.2 in.) long by 5 mm (2.0 in.) deep.*

*Two 1.0  $\mu$ F 600 V  $\pm$  10 percent capacitors shall be installed on the output field terminal strip for left turn phases which are normally odd numbered and shall be connected from the green output terminal to AC negative terminal on odd numbered phases and the other capacitor will be connected from the yellow output terminal to AC negative on odd numbered phases.*

*Each inductive device, including the fan, shall have a separate power surge protection.*

*The terminals for  $\pm$ AC input to the cabinet shall be capable of accepting a No.6 wire.*

*The manual flashing switch shall be wired to let the controller operate when the signals are flashing.*

*The cabinet shall contain a jack mounted type 3 solid state flasher in accordance with NEMA TS2-6.3 or an approved non-repairable unit in accordance with NEMA TS2-6.3 electrical and physical dimensions. Repairable flashers shall consist of opto-or photo-isolated solid state power relays.*

*The phase or phases that the controller shall initialize in green shall be wired to flash yellow. All other phases shall be wired to flash red. Flashing for even numbered phases shall be on one circuit and flashing for odd numbered phases on the other circuit.*

*The cabinet shall contain solid state load switches with an incandescent lamp load rating of 1200 W with nominal 120 V 60 Hz in accordance with NEMA TS2-6.1. The cabinet shall be wired to activate the pedestrian timing, including load switches and all other necessary components. The pedestrian load switch and the signal load switch shall*

*be a triple signal load switch in accordance with NEMA TS2-6.2 or approved non-repairable units in accordance with NEMA TS2-6.1 electrical and physical dimension requirements. The repairable load switches shall consist of opto-or photo-isolated solid state power relays. The load switch shall not use a printed circuit board to achieve the functions of the load switch. Each load switch shall have an indicator for each circuit indicating the status of the input to the load switch.*

*The load switch signal outputs shall be brought to a separate terminal strip for hook up of the signal displays. Load switches can be programmed for flash with the use of a standard slotted or phillips screwdriver or standard nut driver.*

*TS 2 Type A2 controller assembly load switch programming of overlaps, vehicular and pedestrian inputs shall be accomplished on the front of the cabinets' terminal and facilities panel. Inputs shall be programmed by installing or removing electrical conductors, with the use of a standard slotted or phillips screwdriver or standard nut driver.*

*The load switch input programming of the TS2 Type A1 controller assembly shall be accomplished through front panel controller data entry of a TS2 Type A1 or Type A2 CU.*

*The cabinet shall contain the controller assembly and all major devices such as MMU, BIU, vehicle detectors, +24/12 volts DC power supply, load switches, flasher, or other items if specified. All terminal facilities and fusing within the cabinet shall be readily accessible for field connection without removing the controller or associated equipment. All equipment and terminals shall be readily accessible for maintenance in the cabinet.*

***b. Auxiliary Interface Panels Within Controller Assembly.*** *The telemetry interface panel shall include a socket-mounted communication line surge protector. The protector shall be a four wire module with printed circuit board connector. The protector shall be a hybrid device with the first stage formed by a three element gas tube that shall withstand a peak surge current of 10,000 A. The second stage shall dissipate at a minimum of 1.5 KW. The protector shall have a clamp voltage of 8 V. The PCB contact fingers shall be gold plated and shall join with a 10 circuit base connector. No tools shall be required for the insertion and removal of surge protection.*

*A vehicle detector amplifier rack shall be provided with the controller assembly. A size 5 controller assembly shall have eight channels of loop detection with two channels per vehicle phase. A size 6 controller assembly shall have 16 channels of detection with two channels per vehicle phase.*

*Each cabinet shall contain a detector interface panel. As a minimum, an eight position panel shall be provided for a size 5 cabinet and a 16 position panel shall be*



*provided for a size 6 cabinet. The panel shall have two loop lead-ins with ground wire, wired and functional for each detector channel. The interface panel shall be secured on the left sidewall of the cabinet.*

***c. Controller Assembly Major Units.** The MMU shall be in accordance with NEMA TS2-4, all applicable environmental requirements and tests set forth in NEMA TS2-2, and the following specifications.*

*The +12/24 volts DC power supply shall be in accordance with NEMA TS2-5.3.5. The +12/+24 volts DC power supply shall include LED indicators to display the status of all outputs. The power supply shall be shelf mounted. Internal wiring and components shall be readily accessible for replacement and servicing of parts. The power supply shall include banana jack style test points on the front panel for the +24 volts DC, and logic ground. The serial number corresponding to the material list shall be permanently applied to the enclosure of the unit.*

*The BIU shall be in accordance with NEMA TS2-8.1 and the applicable requirements of NEMA TS2-3.3.1. The BIU shall have the serial number corresponding to the material list permanently applied to the unit.*

***d. Controller Assembly Delivery Requirements.** The cabinets and CAs purchased by the Department shall have each cabinet package marked with the Department's last four digits of the requisition number from the purchase order. The packaging shall also be numbered identifying the cabinet and its corresponding CA prints manuals and parts list. The identifying numbers shall be consecutive with the first and last delivery of the purchase order. A cabinet without the entire set of controller assembly materials will not be considered complete. Payment will not begin until all required materials for the cabinet and CA are received.*

***e. Cabinet Installation Requirements.** The size 5 and 6 cabinets shall be ground mounted on a concrete foundation at the locations and dimensions as shown on the plans with anchor bolts in accordance to 913.15(a)7.1e.*

SECTION 913, LINE 3178, DELETE AND INSERT AS FOLLOWS:

**(b) Interconnection Equipment Blank.**

SECTION 913, DELETE LINES 3179 THROUGH 3241.